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UTILITY PATENT APPLICATION TRANSMITTAL <small>(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))</small>	Attorney Docket No.	ATI-000150BT
	First Inventor or Application Identifier	Feliks Dujmenovic
	Title	IMAGE REJECTION MIXING IN WIDEBAND APPLICATIONS
	Express Mail Label No.	EL703379723US

APPLICATION ELEMENTS <small>See MPEP chapter 600 concerning utility patent application contents</small> 1. <input checked="" type="checkbox"/> * Fee Transmittal Form (e.g., PTO/SB/17) <small>(Submit an original and a duplicate for fee processing)</small> 2. <input checked="" type="checkbox"/> Specification [Total Pages 10] <small>(preferred arrangement set forth below)</small> - Descriptive title of the Invention - Cross References to Related Applications - Statement Regarding Fed sponsored R & D - Reference to Microfiche Appendix - Background of the Invention - Brief Summary of the Invention - Brief Description of the Drawings (if filed) - Detailed Description - Claim(s) - Abstract of the Disclosure 3. <input checked="" type="checkbox"/> Drawing(s) (35 U.S.C. 113) [Total Sheets 2] 4. Oath or Declaration [Total Pages 2] a. <input checked="" type="checkbox"/> Newly executed (original or copy) b. <input type="checkbox"/> Copy from a prior application (37 C.F.R. § 1.63(d)) <small>(for continuation/divisional with Box 16 completed)</small> i. <input type="checkbox"/> <u>DELETION OF INVENTOR(S)</u> <small>Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).</small> <div style="border: 1px solid black; padding: 2px; font-size: small;">* NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).</div>	ADDRESS TO: Commissioner for Patents Box Patent Application Washington, DC 20231 5. <input type="checkbox"/> Microfiche Computer Program (Appendix) 6. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary) a. <input type="checkbox"/> Computer Readable Copy b. <input type="checkbox"/> Paper Copy (identical to computer copy) c. <input type="checkbox"/> Statement verifying identity of above copies ACCOMPANYING APPLICATION PARTS 7. <input checked="" type="checkbox"/> Assignment Papers (cover sheet & document(s)) 8. <input type="checkbox"/> 37 C.F.R. § 3.73(b) Statement <input type="checkbox"/> Power of Attorney <small>(when there is an assignee)</small> 9. <input type="checkbox"/> English Translation Document (if applicable) 10. <input type="checkbox"/> Information Disclosure Statement (IDS)/PTO-1449 <input type="checkbox"/> Copies of IDS Citations 11. <input type="checkbox"/> Preliminary Amendment 12. <input checked="" type="checkbox"/> Return Receipt Postcard (MPEP 503) <small>(Should be specifically itemized)</small> 13. <input type="checkbox"/> * Small Entity Statement(s) <input type="checkbox"/> Statement filed in prior application, Status still proper and desired <small>(PTO/SB/09-12)</small> 14. <input type="checkbox"/> Certified Copy of Priority Document(s) <small>(if foreign priority is claimed)</small> 15. <input type="checkbox"/> Other: _____
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16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:
☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No: _____
Prior application information: Examiner _____ Group / Art Unit: _____
For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

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Name (Print/Type)	Kao H. Lu, Esquire	Registration No (Attorney/Agent)	43,761
Signature		Date	9/26/00

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Patent fees are subject to annual revision.

Small Entity payments must be supported by a small entity statement, otherwise large entity fees must be paid. See Forms PTO/SB/09-12.

See 37 C.F.R. §§ 1.27 and 1.28.

TOTAL AMOUNT OF PAYMENT (\$690.00)

Complete if Known

Application Number	Not Yet Known
Filing Date	Not Yet Known
First Named Inventor	Feliks Dujmenovic
Examiner Name	Not Yet Known
Group / Art Unit	Not Yet Known
Attorney Docket No.	ATI-000150BT

METHOD OF PAYMENT (check one)

- 1.
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- The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:

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50-0441

Deposit Account Name

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☒ Charge Any Additional Fee Required Under 37 CFR §§ 1.16 and 1.17

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
101 690	201 345	Utility filing fee	690
106 310	206 155	Design filing fee	
107 480	207 240	Plant filing fee	
108 690	208 345	Reissue filing fee	
114 150	214 75	Provisional filing fee	

SUBTOTAL (1) (\$690.00)

2. EXTRA CLAIM FEES

Total Claims	Extra Claims	Fee from below	Fee Paid
15	20* = 0	18	0
Independent Claims 3	3** = 0	78	0
Multiple Dependent			0

**or number previously paid, if greater; For Reissues, see below

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description
103 18	203 9	Claims in excess of 20
102 78	202 39	Independent claims in excess of 3
104 260	204 130	Multiple dependent claim, if not paid
109 78	209 39	** Reissue independent claims over original patent
110 18	210 9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) (\$0.00)

FEE CALCULATION (continued)

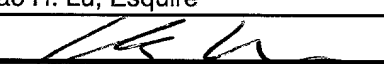
3. ADDITIONAL FEES

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
105 130	205 65	Surcharge - late filing fee or oath	
127 50	227 25	Surcharge - late provisional filing fee or cover sheet	
139 130	139 130	Non-English specification	
147 2,520	147 2,520	For filing a request for reexamination	
112 920*	112 920*	Requesting publication of SIR prior to Examiner action	
113 1,840*	113 1,840*	Requesting publication of SIR after Examiner action	
115 110	215 55	Extension for reply within first month	
116 380	216 190	Extension for reply within second month	
117 870	217 435	Extension for reply within third month	
118 1,360	218 680	Extension for reply within fourth month	
128 1,850	228 925	Extension for reply within fifth month	
119 300	219 150	Notice of Appeal	
120 300	220 150	Filing a brief in support of an appeal	
121 260	221 130	Request for oral hearing	
138 1,510	138 1,510	Petition to institute a public use proceeding	
140 110	240 55	Petition to revive - unavoidable	
141 1,210	241 605	Petition to revive - unintentional	
142 1,210	242 605	Utility issue fee (or reissue)	
143 430	243 215	Design issue fee	
144 580	244 290	Plant issue fee	
122 130	122 130	Petitions to the Commissioner	
123 50	123 50	Petitions related to provisional applications	
126 240	126 240	Submission of Information Disclosure Stmt	
581 40	581 40	Recording each patent assignment per property (times number of properties)	
146 690	246 345	Filing a submission after final rejection (37 CFR § 1.129(a))	
149 690	249 345	For each additional invention to be examined (37 CFR § 1.129(b))	
Other fee (specify) _____			
Other fee (specify) _____			

* Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$0.00)

SUBMITTED BY

Name (Print/Type)	Kao H. Lu, Esquire	Registration No. (Attorney/Agent)	43,761	Telephone	215-568-6400
Signature				Date	9/26/00

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IMAGE REJECTION MIXING IN WIDEBAND APPLICATIONS

BACKGROUND

This invention generally relates to wideband communication systems. In particular, the invention relates to image suppression in received wideband communications.

Wideband communication systems, such as television and radio communication systems, use a wide frequency spectrum to communicate information. Typically, the wide spectrum is divided into a group of assigned radio frequencies for carrying the information.

In a heterodyne receiver, the received signal is amplified by a radio frequency (RF) amplifier and mixed with an adjustable local oscillator (LO) signal to produce intermediate frequency (IF) signal. One problem with mixer circuits is the generation of image frequency signals.

When two signals are mixed, signal components are produced at the sum and difference of the two signals, and their harmonics. Equation 1 illustrates the potential signal components where F_{LO} is a local oscillator frequency being mixed with a radio frequency, F_{RF} and m and n are integers or zero.

$$\pm m F_{RF} \pm n F_{LO} \quad \text{Equation 1}$$

Since input circuits typically have limited selectivity in the mixing process, undesired interference may create harmful products, as illustrated by Equation 2. F_I is an undesired interference frequency and m , n and p are an integer or zero.

$$\pm m F_{RF} \pm n F_{LO} \pm p F_I \quad \text{Equation 2}$$

For example, when an intermediate frequency signal, F_{RF} , is mixed with a local oscillator, F_{LO} , the result will produce signals at two frequencies, $F_{LO} + F_{RF}$ and $F_{LO} - F_{RF}$. One of the two signals is the desired frequency and the other is at an undesired frequency. Additionally, based on the quality of the mixers, undesirable harmonics, such as $F_{LO} + 2F_{RF}$, could also be produced. In a wideband communication system utilizing multiple frequencies, the frequencies that these undesired signals fall upon may be the same frequency used for another information signal. As a result, the undesired signal produces an image on the desired information signal at that frequency.

One approach to removing the image signal from the desired signal is by filtering. Typically, filtering only reduces the magnitude of the image signal by less than 30 decibels (dB). In some applications, a 30 dB attenuation is not sufficient.

Another approach is to use an image rejection mixer 10, as illustrated in Figure 1. A received radio frequency signal is input into the image rejection mixer 10. The received signal is input to an in-phase mixer 14 and a quadrature phase mixer 12. A local oscillator (LO) 11 generates a carrier signal. The carrier signal is input into the quadrature phase mixer 12 to produce a demodulated quadrature phase signal and into a 90 degree phase shift device 16, such as a RC-CR circuit, to produce an in-phase carrier. The in-phase carrier is input into the in-phase mixer 12 to produce a demodulated in-phase signal. The demodulated quadrature phase signal is subsequently delayed by a 90 degree phase shift device 22. An adder 20 combines the phase delayed quadrature phase signal to the in-phase signal to produce the desired signal. Typically, the image signal will be out of phase with the desired signal. As a result, the combining cancels the image signal leaving only the desired signal.

To illustrate, W_{RF} is the frequency of the received signal and W_{LO} is the frequency at the local oscillator. The image rejection mixer 10 processes the desired signal as follows. $I(t)$ is the demodulated in-phase signal. $Q(t)$ is the demodulated quadrature phase signal. $Q'(t)$ is the phase delayed quadrature phase signal. $O(t)$ is the subtracted signal.

$$\begin{aligned}
 I(t) &= \cos(W_{RF}t) * \cos(W_{LO}t) = \\
 &= \frac{1}{2} [\cos(W_{RF} - W_{LO})t + \cos(W_{RF} + W_{LO})t], \text{ where } W_{RF} - W_{LO} > 0
 \end{aligned}$$

Equation 3

The $\cos(W_{RF} + W_{LO})t$ is removed by low-pass filtering.

$$\begin{aligned}
 Q(t) &= \cos(W_{RF}t) * \cos(W_{LO}t - \pi/2) = \\
 &= \frac{1}{2} \cos[(W_{RF} - W_{LO})t + \pi/2] = -\frac{1}{2} \sin(W_{RF} - W_{LO})t
 \end{aligned}$$

Equation 4

$$Q'(t) = -\frac{1}{2} \sin[(W_{RF} - W_{LO})t - \pi/2] = \frac{1}{2} \cos(W_{RF} - W_{LO})t$$

Equation 5

$$O(t) = I(t) + Q'(t) = \cos(W_{RF} - W_{LO})t$$

Equation 6

The image rejection mixer 10 processes the image signal which is inverted with respect to the desired signal as follows.

$$I(t) = \frac{1}{2} \cos[-(W_{RF} - W_{LO})t] = \frac{1}{2} \cos(W_{RF} - W_{LO})t$$

Equation 7

$$Q(t) = \frac{1}{2} \cos[-(W_{RF} - W_{LO})t + \pi/2] = \frac{1}{2} \sin(W_{RF} - W_{LO})t$$

Equation 8

$$Q'(t) = \frac{1}{2} \sin[(W_{RF} - W_{LO})t - \pi/2] = -\frac{1}{2} \cos(W_{RF} - W_{LO})t$$

Equation 9

$$O(t) = I(t) + Q'(t) = \frac{1}{2} \cos(W_{RF} - W_{LO})t - \frac{1}{2} \cos(W_{RF} - W_{LO})t = 0$$

Equation 10

Accordingly, after image cancellation, the desired signal is recovered, Equation 6, and the image signal is canceled, Equation 10.

Due to variations in the tolerances of the resistors and capacitors in the phase shift device 16 and temperature variations, the phase differential between the carrier and the quadrature carrier may not be maintained at an ideal 90 degrees, degrading performance of the image mixer.

- 5 Accordingly, it is desirable to have alternate approaches for image suppression in received wideband signals.

SUMMARY

10 A ring oscillator produces an in-phase and quadrature phase radio frequency signal. A first mixer mixes the in-phase signal with a received signal. A second mixer mixes the quadrature phase signal with the received signal. A combiner, operatively coupled to the first and second mixers, produces an image cancelled signal.

BRIEF DESCRIPTION OF THE DRAWINGS

15 Figure 1 is an image rejection mixer.

Figure 2 is an image rejection mixer using a ring oscillator.

Figure 3 is a delay cell.

Figure 4 is a RC-CR circuit.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

20 Figure 2 illustrates an image rejection mixer 24 for use in a wideband communication system receiver, such as a television tuner or radio tuner. Although the image rejection mixer 24 is shown using balanced mixers 28, 30, such as a Gilbert cell, other mixers may be used. Balanced mixers are desirable due to their noise suppression quality. A received RF signal is buffered by a buffer 58 so that the RF signal as outputted by the buffer 58 is shifted to a desired level for the in-phase and quadrature mixers 30, 28. The buffered RF signal is inputted into both the in-phase and quadrature phase mixers 30, 28. A ring oscillator 32 produces an in-phase carrier which is input into the in-phase mixer 30 and a quadrature phase carrier which is input to the quadrature

phase mixer 28. The demodulated quadrature phase signal is subsequently delayed by a 90° phase delay device 38, such as an RC-CR circuit. The delayed quadrature phase signal is combined using an adder 40 to the in-phase signal to produce the desired signal with the image signal cancelled.

5 By using the ring oscillator 32, the in-phase and quadrature carrier are maintained at a near ideal 90 degree phase difference. Since the demodulated signals are at low frequencies, a simpler 90 degree phase shift device 38, such as an RC-CR circuit, may be used without degrading the image rejection mixer's performance. Using the ring oscillator 32, a 60 dB attenuation in the image signal is achieved.

10 One ring oscillator 32 for producing the in-phase and quadrature phase carrier uses four delay cells 44₁-44₄, as shown in Figure 2. Each delay cell 44₁-44₄ delays the input signal by 45 degrees. As a result, the first delay cell 44₁ produces a 45 degree phase delay. The second delay cell delays the 45 degree delayed signal by another 45 degrees, totaling 90 degrees. The output of the second delay cell 44₂ is inverted as to shift the phase by 180 degrees prior to being input into the third delay cell 44₃. The third delay cell 44₃ delays the 270 degree delayed signal by 45 degrees, totaling 315 degrees. The fourth cell 44₄ delays the output of the third cell 44₃ by 45 degrees totaling 360 degrees creating the oscillation. Although the output of the second cell 44₂ is shown as used for the in-phase carrier and the output of the fourth cell 44₄ for the quadrature phase carrier, any of the outputs or inputs separated by 90 degrees may be used.

20 One circuit for use as a delay cell 44₁-44₄ is shown in Figure 3 using CMOS circuitry. Six n-type MOSFETS 46₁-46₆ and two p-type MOSFETS 48₁, 48₂ are configured as shown in Figure 3. The inputs to the gates of the two bottom n type MOSFETS 46₁, 46₂ are connected in series to form the bias, control frequency, to the delay cells 44₁-44₄. The gates of the two lower n type MOSFETS 46₃, 46₆ form the input of the delay cells 44₁-44_n. The drains of those MOSFETS 46₃, 46₆, form the output. This CMOS circuit produces an output having a phase delayed by 45 degrees from the input.

A simple 90 degree phase shift device 38 may be used for the quadrature phase demodulated signal, such as a RC-CR circuit as shown in Figure 4. The demodulated

quadrature phase signal is input into the delay device 38. The input of the delay device 38 is coupled to a series connected resistor 50 and capacitor 52 connected in parallel to a series connected capacitor 54 and resistor 56. An output of 90 degrees of phase delay is produced at the nodes between the series connected resistors 50, 56 and capacitors 52, 54.

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CLAIMS

What is claimed is:

1. An apparatus for canceling an image signal from a received radio frequency signal, the apparatus comprising:

a ring oscillator for producing a radio frequency signal having in-phase and quadrature phase components;

5 a first mixer having inputs configured to receive the in-phase component and the received radio frequency signal and outputting an in-phase signal;

a second mixer having inputs configured to receive the quadrature phase component and the received radio frequency signal and outputting a quadrature phase signal;

a phase shift device coupled with one of the mixers for receiving an output of the one mixer and outputting a phase shifted signal; and

a combiner, operatively coupled to the other of the mixers and said phase shift device, for producing an image cancelled signal.

2. The apparatus of claim 1 wherein the phase shift device is coupled to the second mixer.

3. The apparatus of claim 2 wherein the phase shift device shifts a phase of the second mixer output by ninety degrees.

4. The apparatus of claim 1 wherein the ring oscillator comprises four delay cells, an output of each delay cell is coupled to an output of another of the delay cells.

5. The apparatus of claim 4 wherein each delay cell delays its input by forty-five degrees and one of the couplings is cross-coupled so that the output of one of the delay cells is inverted prior to input into another of the delay cells.

6. The apparatus of claim 1 wherein the first mixer and the second mixer are gilbert cells.

7. A receiver for use in a wideband communication system, the receiver capable of canceling an image signal from a received radio frequency signal, the receiver comprising:

a ring oscillator for producing a radio frequency signal having in-phase and quadrature phase components;

first mixing means for mixing the in-phase component with the received radio frequency signal and outputting an in-phase signal;

second mixing means for mixing the quadrature phase component with the received radio frequency signal and outputting a quadrature phase signal;

means for receiving one of the mixer's phase signals and outputting a phase shifted signal; and

means for combining the phase shifted signal with the phase signal other than the one phase signal to produce an image canceled signal.

8. The receiver of claim 7 wherein the means for outputting a phase shifted signal shifts the one phase signal by ninety degrees in phase.

9. The receiver of claim 7 wherein the ring oscillator comprises four delay cells, an input of each delay cell is coupled to an output of another of the delay cells.

10. The receiver of claim 9 wherein each delay cell delays its input by forty-five degrees and one of the couplings is cross-coupled so that the output of the delay cell is inverted prior to input into another of the delay cells.

11. The receiver of claim 7 wherein the means for outputting a phase shift signal is coupled to the first mixing means.

12. The receiver of claim 7 wherein the first and second mixing means comprises a gilbert cell.

13. A method for canceling an image signal from a received radio frequency signal, the method comprising:

providing a ring oscillator;

producing a radio frequency signal having in-phase and quadrature phase components with the ring oscillator;

mixing the in-phase component and the received radio frequency signal to produce an in-phase signal;

mixing the quadrature phase component and the received radio frequency signal to produce a quadrature phase signal;

shifting a phase of one of the phase signals produced by mixing the components to produce a phase shifted signal; and

combining the phase shifted signal with the phase signal produced by mixing the components other than the one phase signal to produce an image canceled signal.

14. The method of claim 13 wherein the one phase signal is the quadrature phase signal.

15. The method of claim 13 wherein the phase shifting is by ninety degrees in phase.

ABSTRACT

A ring oscillator produces an in-phase and quadrature phase radio frequency signal. A first mixer mixes the in-phase signal with a received signal. A second mixer mixes the quadrature phase signal with the received signal. A combiner, operatively
5 coupled to the first and second mixers, produces an image cancelled signal.

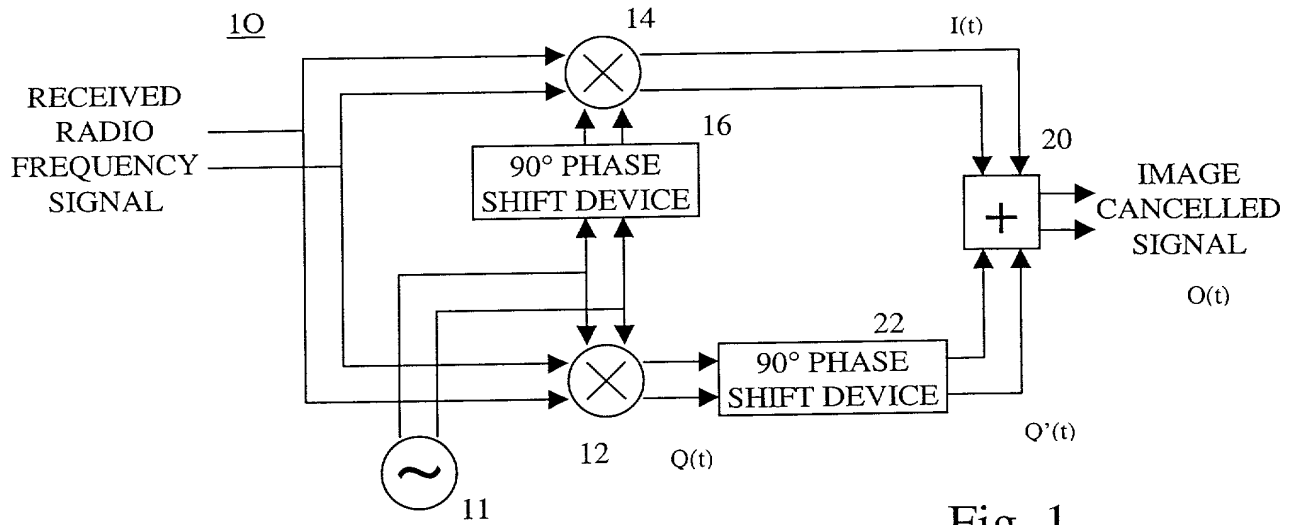


Fig. 1

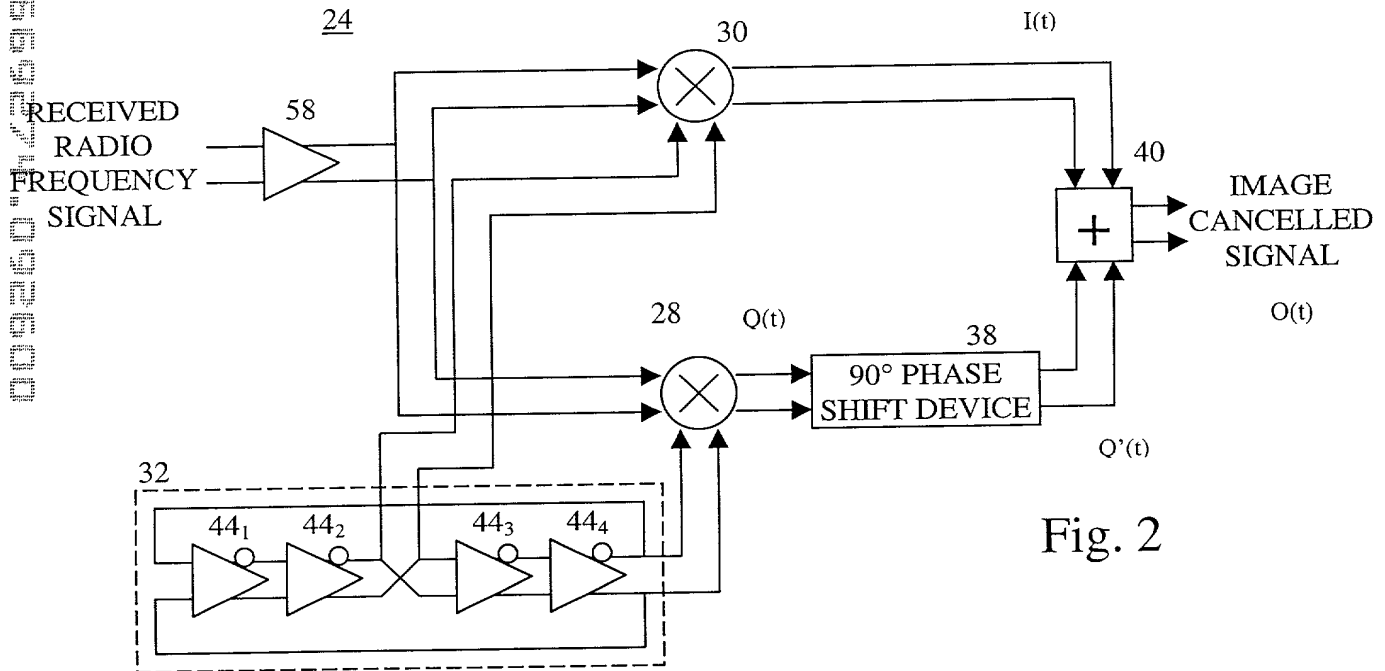


Fig. 2

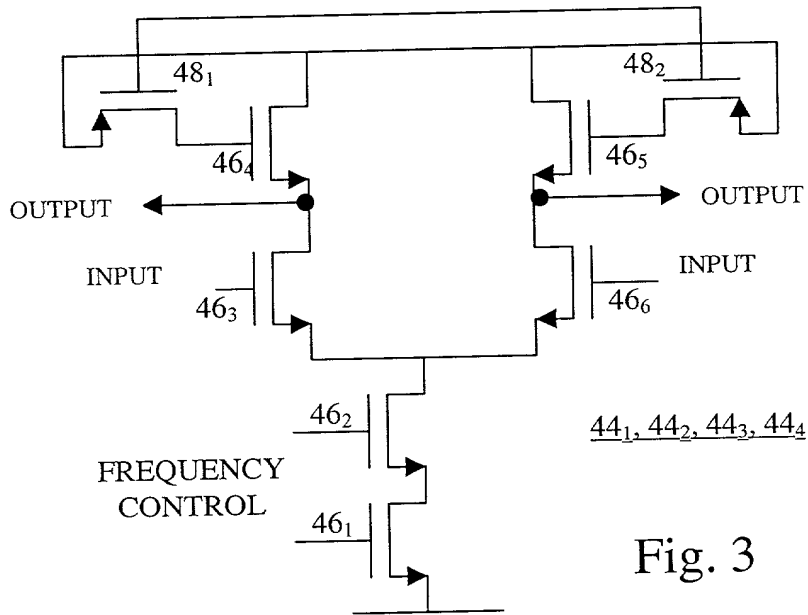


Fig. 3

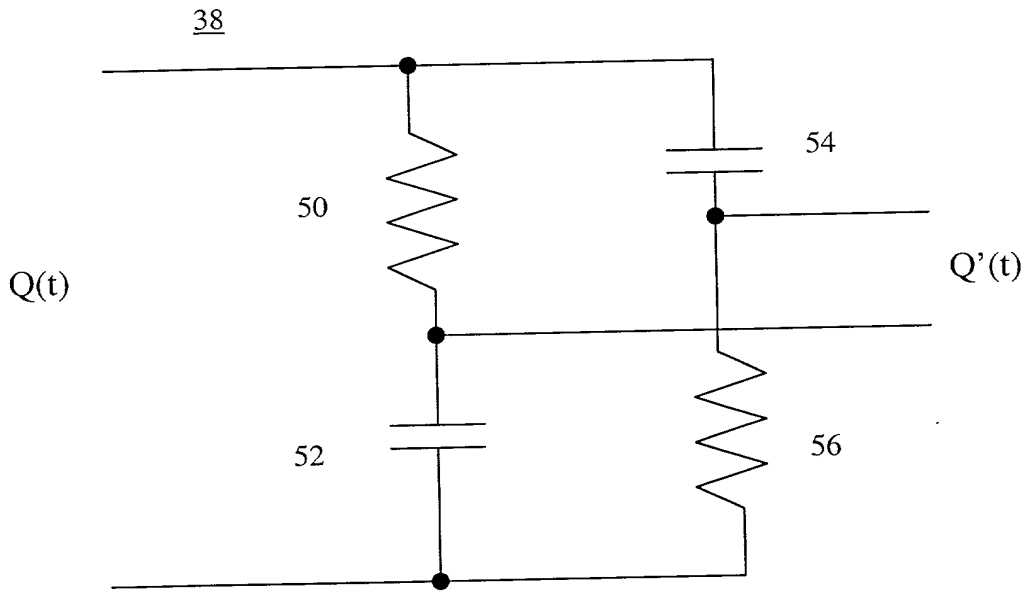


Fig. 4

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63) <input checked="" type="checkbox"/> Declaration Submitted with Initial Filing OR <input type="checkbox"/> Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)	Attorney Docket Number	ATI-000150BT
	First Named Inventor	Feliks Dujmenovic
	COMPLETE IF KNOWN	
	Application Number	Not Yet Known
	Filing Date	Not Yet Known
	Group Art Unit	Not Yet Known
	Examiner Name	Not Yet Known

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

IMAGE REJECTION MIXING IN WIDEBAND APPLICATIONS

the specification of which (Title of the Invention)

☐ is attached hereto

OR

☐ was filed on (MM/DD/YYYY) as United States Application Number or PCT International

Application Number and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(s) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?	
				YES	NO
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	<input type="checkbox"/> Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

(Page 1 of 2)

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT International application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

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As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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Name	Registration Number	Name	Registration Number
Namely, the Attorneys of Volpe and Koenig, P.C.			

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☒ Customer Number 25310 OR ☐ Correspondence address below

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City		State		ZIP	
Country		Telephone		Fax	

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor:

☐ A petition has been filed for this unsigned inventor

Given Name (first and middle (if any))		Family Name or Surname	
Feliks		Dujmenovic	
Inventor's Signature			Date
			Sept 21, 2000
Residence: City	Richmond Hill	State	Ontario
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☐ Additional inventors are being named on the supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto